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(54) IMPROVEMENTS IN OR RELATING TO MULTI-LAYER CIRCUIT STRUCTURES

(71) We, TELEFUNKEN PATENTVERWERTUNGSGESELLSCHAFT m.b.H., of Ulm/Donau, Elisabethenstrasse 3, Germany, a German company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to the manufacture of multilayer printed circuit structures and more particularly to such structures of the kind comprising a plurality of insulating support plates upon which printed circuits are formed in metal cladding on both major faces of each support plate and which are stuck together in a pack to provide at least four layers of printed circuits formed from the metal cladding of the plates, the pack having metal lined holes extending right through it which serve to provide connections between different layers of printed circuits and are adapted to receive and make connection with circuit components to be associated with the structure. Such structures will hereinafter be denoted by the term "structures of the kind referred to".

Printed circuit structures of the kind referred to are becoming increasingly required because of the complexity of the circuitry they can accommodate. Such structures are often used in conjunction with circuit components mounted directly on the outer surface or surfaces of the structure and connected to the circuitry through the metal lining in the holes. Such structures are also often used to provide required electric connections between different printed circuit cards on which circuit components are mounted. The metal linings in the holes of the structure in this case provide connections between the circuitry incorporated in the structure and component contacts or terminals on the different printed circuit cards when the terminals of the printed circuit cards are inserted into the metal lined holes.

[*Price 25p*]

The present invention seeks to provide improved and simple methods of making multilayer printed circuit structures of the kind referred to which shall not require the employment of expensive tools when the several support plates are being stuck together; which shall not involve a high percentage of rejects due to faulty, unreliable or inadequate electrical contact between metal lining in the holes and the printed circuits; and which despite its simplicity and cheapness to practice, can be used to produce multi-layer printed circuit structures of the kind referred to of high quality and closely in accordance with pre-determined designs.

According to this invention a method of manufacturing a multi-layer printed circuit structure of the kind referred to includes the steps of making similar holes in corresponding positions in a plurality of insulating support plates each having metal-clad surfaces on both major faces thereof, depositing metal on the walls of the holes to form metal linings thereon, forming required printed circuits from all those metal cladding surfaces which, when the pack is assembled, will be internal surfaces with respect to the pack, applying adhesive to the said internal surfaces of the thus prepared support plates, stacking said plates with the holes aligned and holding them stacked until they are stuck together by adhesive which has set, cleaning out the aligned holes to remove adhesive from the interior thereof thus leaving the metal linings with clean inner surfaces, depositing more metal on the clean inner surfaces of the first deposited metal linings, and forming required printed circuits from the two metal cladding surfaces which constitute the outer surfaces of the pack.

Because the method of this invention starts with thin insulating support plates metallised on both major faces, the final structure is strong and compact, comparing favourably in these respects with similar structures made

by the known processes at present generally employed.

A very simple tool can be used for ensuring accurate registration when making guide holes in the support plates, and if desired in film negatives and printing screens used in the process of making the printed circuits from the metal cladding. Such a tool may consist of two metal platens one of which supports guide pins and the other of which has correspondingly positioned drilled holes. The guide pins ensure that in all the necessary operations the support plates are accurately positioned relative to each other. To make the guide holes in the support plates, (and if desired in the film negatives and printing screens) these parts are first of all assembled in a stack between the metal platens, the platens having themselves been correctly positioned in correspondence with the positions of the guide holes required. These guide holes are then punched through.

The invention is illustrated in and further explained in connection with the accompanying schematic drawings.

Referring to Figure 1, this represents a support sheet as well known per se and consisting of an insulating sheet 1 which is metallised on both sides, the metal cladding being indicated at 2 and 3. A number of such plates are used. Each such plate has dimensions large enough for it to extend all round beyond what are intended to be the limits of the dimensions of the finished article ultimately produced. In the example illustrated each support plate is wider and longer than the corresponding dimensions of the finished article so as to leave a margin all round of, for example, 15 mm. In Fig. 1 extended portions are indicated by the references 1a and 1b above and below the broken lines which represent the ends of the corresponding intended dimensions in the finished article. A suitable tool—preferably a tool as hereinbefore described—is used to assist the punching of guide holes in the projecting ends of the plates. In order to ensure accurate registry these holes are preferably made simultaneously in a set of superimposed plates which will subsequently be cemented together to form a multilayer printed circuit pack. During this operation guide holes may also be simultaneously made in the printing screens or film negatives which will subsequently be used for printing the conductive patterns on the metallised surfaces of the support plates. Fig. 2 shows a pack of support plates with guide holes 4, the said Fig. 2 showing three superimposed support plates and being therefore suitable for the case in which a printed circuit pack with six conductor pattern layers is required. A number of holes are drilled right through the superimposed set of support plates, to enable electrical connections to be made. For this purpose the plates are held in register by means of guide pins 6 inserted in the guide holes 4, as shown in Fig. 2. Holes 5 in the positions required in the conductive patterns are then made by drilling simultaneously through the set of plates. In order to facilitate accurate positioning of the holes 5 a suitable pattern picture showing the hole positions, and produced in any convenient known manner, e.g. photographically, may first be applied to one flat outer surface of the superimposed registered set of plates. The individual plates are then separated from each other. The separated plates are then "through-plated" by any suitable known process to produce layers of suitable metal, e.g. copper, deposited on the walls of the pattern holes 5 to line the same to a suitable thickness. Such hole lining deposits are indicated at 6′ in Fig. 3 which shows one of the plates at this stage of manufacture. The required circuits are then produced on those metallised plate surfaces which, when the plates are assembled in a pack, will be internal surfaces. These circuit patterns may be produced by any known suitable printed circuit process. Those metallised surfaces which, when the pack is assembled, will be the two outer flat surfaces of the pack are not formed with printed circuits at this time. The plates are then cemented together as will now be described with the aid of Fig. 4 to form a pack. First the individual plates are stacked on a mounting jig having guide pins 7 over which the guide holes 4 are fitted. Where desired, when thus stacking the plates, sheets of insulating foil 8 may be inserted between neighbouring plates. Also, before stacking the plates on the guide pins 7, they are coated on both sides with a suitable adhesive, for example that known under the Registered Trade Mark of Araldite. The stack is then squeezed under pressure between the plates 9 and 10 of a press and held thus until the adhesive sets. The setting of the adhesive, if of a thermal setting type, can be accelerated by placing the pack in an oven, for example at 100°C. In Figure 4 layers of adhesive are represented at 11. In practice, of course, the adhesive layer thickness is quite small—in fact none of the thicknesses shown in the drawings are to be taken as being correctly to scale.

Under pressure surplus adhesive flows into the pattern holes 5 and tends to fill them up, as represented in Fig. 4 at 12. Adhesive is accordingly removed from the pattern holes 5 and also insulating foil 8, which at this stage extends across them, is removed. This is done by drilling with the aid of a drill of slightly smaller diameter than that used previously to drill the pattern holes. For example if the pattern holes have been drilled with a 1 mm drill then a 0.95 mm drill may be used to clear them of adhesive. This second drilling operation will in practice remove some of

the metal lining 6 but will still leave most of it in place. For example if the lining layer thickness was 35μm the second drilling operation will still leave a thickness of 25 μm and will ensure clean surfaces. Fig. 5 represents the pack after this second drilling operation. The pattern holes are then through plated a second time to thicken the metal lining layers 6 and at the same time ensure connection of the lining layers 6 of neighbouring plates by bridging over the edges of the insulating foil layers 8. In Fig. 6 the plated copper linings of the pattern holes are represented in heavy lines. In the next operation required circuit patterns are formed on the outer surfaces of the cemented pack by a known printed circuit process. If desired these circuit patterns can be given a final coating of tin by a currentless deposition process. The final operation is to cut off the outer margins of the pack, that is to say the parts 1a and 1b in Fig. 1. The multilayer printed circuit pack is then complete and will appear as shown in Fig. 6. It consists, as will be seen, of support plates each equipped with a printed circuit pattern on both sides, the several support plates being stuck together, where required, with the interposition of insulating foils between plates to form the complete multilayer printed circuit pack which has metal-lined holes right through it.

WHAT WE CLAIM IS:—

1. A method of manufacturing a multilayer printed circuit structure comprising a plurality of insulating support plates upon which printed circuits are formed in metal cladding on both major faces of each support plate and which are stuck together in a pack to provide at least four layers of printed circuits formed from the metal cladding of the plates, the pack having metal lined holes extending right through it which serve to provide connections between different layers of printed circuits and are adapted to receive and make connection with circuit components to be associated with the structure said method including the steps of making similar holes in corresponding positions in a plurality of insulating support plates each having metal-clad surfaces on both major faces thereof, depositing metal on the walls of the holes to form metal linings thereon, forming required printed circuits from all those metal cladding surfaces which, when the pack is assembled, will be internal surfaces with respect to the pack, applying adhesive to the said internal surfaces of the thus prepared support plates, stacking said plates with the holes aligned and holding them stacked until they are stuck together by adhesive which has set, cleaning out the aligned holes to remove adhesive from the interior thereof thus leaving the metal linings with clean inner surfaces, depositing more metal on the clean inner surfaces of the first deposited metal linings, and forming required printed circuits from the two metal cladding surfaces which constitute the outer surfaces of the pack.

2. A method as claimed in claim 1 wherein corresponding holes in the different support plates are made in one operation by mounting the plates one above the other in a stack and drilling or punching right through said stack, the plates being then separated for deposition of the metal to form linings in the holes and for formation of printed circuits.

3. A method as claimed in claim 1 or 2 wherein the pack includes one or more insulating foils inserted between neighbouring plates during stacking of the same after formation of the printed circuits.

4. A method as claimed in any of the preceding claims wherein cleaning out of each aligned hole is effected by drilling through it with a drill or such a diameter that the thickness of the metal linings in each aligned hole is reduced.

5. A method as claimed in any of the preceding claims wherein the original metal clad supporting plates in which the holes are formed have dimensions larger than those ultimately required in the finished structure so as to provide margins extending beyond the ends of the latter dimensions, said margins being provided with holes in corresponding positions to receive the guide pins of a jig for holding the plates stacked in their correct relative positions, said margins being cut away after the plates have been stuck together to form the required pack.

6. A method as claimed in claim 5 wherein the stacked adhesive coated plates are held together under pressure while on said jig until the adhesive has set.

7. Methods of making multi-layer printed circuit structures substantially as herein set forth with reference to the accompanying drawings.

8. Multi-layer printed circuit structures when made by a method as claimed in any of the preceding claims.

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1 SHEET This drawing is a reproduction of the Original on a reduced scale

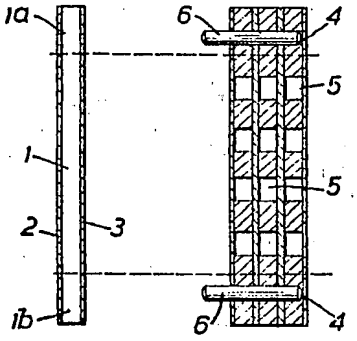

FIG. 1.

FIG. 2.

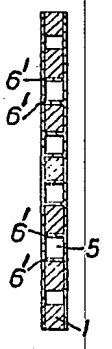

FIG. 3.

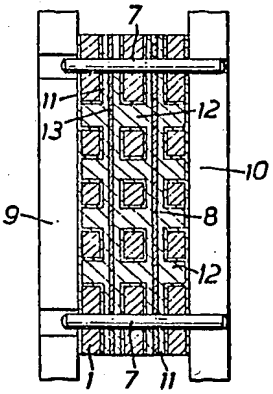

FIG. 4.

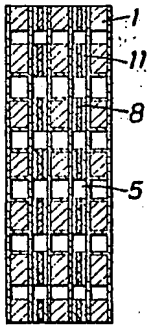

FIG. 5.

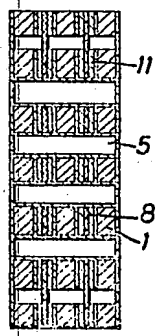

FIG. 6.